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JUL 20 2012

Air/Toxics & Inspection Coordination Branch 6EN-A

Bishop Facility
Highway 77 South
P.O. Box 428
Bishop, TX 78343

July 16, 2012
EIJ-058-12
TPI Project – 07082011-MISC

Certified Mail
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Mr. David Eppler
Air Toxics and Inspection Coordination Branch
U.S.EPA Region 6
1445 Ross Avenue
Dallas, TX 75202-2733

Subject: **Clean Air Act ("CAA") Section 114 Information Request – Supplemental Monthly Response**

Dear Mr. Eppler,

As agreed to during our meeting on December 20, 2011, Ticona Polymers, Inc. (TPI) is submitting the following update relating to the EPA's Section 114 Information Request. Per our email correspondence of July 3, 2012, this report is being submitted one week from the original due date of July 9, 2012.The team continues to work diligently on this project and will provide the next update by August 6, 2012.

The MO-4 and MO-3 flares were initially classified and designed to operate as non-assisted flares with center steam addition to prevent flash back. The status of both flares has changed to steam assisted due to the addition of center steam. According to 40 CFR Part 60 (Codes of Federal Regulation), flares shall be used only with the net heating value of the gas being combusted at 300 BTU/SCF or greater if the flare is steam-assisted. The BTU value of both flares was calculated using the Lower Heat Value (LHV) of each component in the vent gas stream. The analysis of current NHV of both flares (using 272 BTU/SCF as hydrogen's LHV) suggests that both unit flares will require modification. However, the adjusted LHV value of hydrogen (1212 BTU/SCF) was implemented based on guidance from the EPA. The adjusted LHV value of hydrogen was used to calculate the limit for the net heating value of the gases in the combustion zone ($NHV_{cz\text{-}limit}$), which is the new recommended NHV limit instead of the NHV value of 300 BTU/SCF. See Appendix A.

This calculated limit based on the adjusted hydrogen LHV must exceed the NHV_{CZ} of the flare ($NHV_{cz} \geq NHV_{cz\text{-}limit}$). The calculations indicated that MO-3 $NHV_{cz\text{-}limit}$ is 336.7 BTU/SCF and the current NHV_{cz} is approximately 361.5 BTU/SCF. Therefore, the MO-3 flare already satisfies the regulatory requirement and does not need any modification.

The combustion zone limit calculations for the MO-4 flare suggest that the unit requires more natural gas to meet the regulatory requirement. For the MO-4 flare the $NHV_{cz\text{-}limit}$ is calculated to be 343 BTU/SCF and the current NHV_{cz}, at high rates, is approximately 312.8 BTU/SCF. A project is being implemented to eliminate this deficiency and successfully meet the natural gas capacity to the MO-4 flare. Conversation with

Celanese
Ticona
A business of Celanese

personnel from the manufacturer of the current MO-4 and MO-3 flares, Calladius Technology, confirmed that the flares have the capacity to operate at higher natural gas rates.

Additionally, MO-4 does not require 550M SCFH of natural gas when it is not flaring at high rates. Our future goal is to optimize this system by implementing ratio control. Ratio control will reduce the unnecessary use of natural gas during lower rates and/or start-ups.

Flare Design Requirement and Results

In increasing the natural gas flow to the flare, the following parameters were considered: the tip velocity, NHV of the vent gas, stack height, back pressure and radiation on the ground level. These calculations can be found in Appendix A.

The required net heating value is 300 BTU/SCF for steam-assisted flares and 200 BTU/SCF for non-steam assisted flares. These limits differ when the adjusted net heating value of hydrogen is utilized. The new combustion zone-limit is calculated using the following mathematical equations.

- Lower Flammability Limit (LFL) of the vent gas mixture

$$\mathrm{LFL_{vg}} = \frac{1}{\sum_{i=1}^{n}\left(\frac{x_i}{\mathrm{LFL_i}}\right)} \qquad \text{Eq. 1.1}$$

This calculation uses the weighted average of the LFLs of the individual compounds weighted by their volume fraction of the vent gas. The lower LFLvg for MO-3 is 16% (vol%) and LFLvg for MO-4 is 20% (vol%).

- Net Heating Value (NHV) of the vent gas

$$\mathrm{NHV_{vg}} = \sum_{i=1}^{n}(x_i * \mathrm{NHV_i}) \qquad \text{Eq. 1.2}$$

The adjusted net heating value for hydrogen, 1212 BTU/SCF, was implemented in the vent gas NHV calculation.

- NHV of the vent gas at its LFL (NHVvg-LFL)

$$\mathrm{NHV_{vg-LFL}} = \mathrm{NHV_{vg}} * \mathrm{LFL_{vg}} \qquad \text{Eq. 1.3}$$

This value is used to calculate the new combustion zone limit based on the adjusted hydrogen LHV.

- Combustion efficiency Multipliers to calculate the Net Heating Value Combustion Zone-Limit ($NHV_{cz\text{-}limit}$)

$$\mathrm{NHV_{cz-limit}} = \left(\mathrm{A} + \mathrm{B} * x_{\mathrm{propylene}}\right) * \mathrm{NHV_{vg-LFL}} \qquad \text{Eq. 1.4}$$

Eq. 1.4 is a standard equation used in combustion zone limit calculations. However, the MO-4 and MO-3 process vent does not consist of any propylene; therefore, the following simplified equation is used.

$$NHV_{cz-limit} = (A) * NHV_{vg-LFL} \quad \text{Eq. 1.5}$$

Variable A is based on Table 1.

Minimum Steam	VOC Vent Gas Concentration	A Multiplier	B Multiplier*	
			Condition A	Condition B
≤1000 lb/hr	≤20.0%	6.45	4.0	0.0
≤1000 lb/hr	>20.0%	6.85	4.0	0.0
>1000 lb/hr	≤20.0%	**7.1**	4.0	0.0
>1000 lb/hr	>20.0%	7.4	4.0	0.0

*The B Multiplier used depends on the relationship of hydrogen and propylene in the vent gas as follows:
Condition A: $3 \le H_2 \le 8$ and Propylene% $\ge H_2$% (all percentages are volume or mole percentages)
Condition B: Any condition not meeting the requirements for Condition A.

The Net Heating Value of the gases in the Combustion Zone of a flare is required to ensure acceptable combustion efficiency. Because the adjusted hydrogen LHV is considered in the NHV calculation, the $NHV_{cz\text{-}limit}$ is an adjusted limit which is required to be satisfied in order to comply with this EPA regulation. The $NHV_{cz\text{-}limit}$ for MO-3 is calculated to 337 BTU/SCF and for MO-4 is 343 BTU/SCF.

- NHV of the Combustion Zone Gas (NHVcz)

$$NHV_{cz} = \frac{(Q_{vg} * NHV_{vg}) + (Q_{ng} * NHV_{ng})}{Q_{vg} + Q_{ng} + Q_{steam}} \quad \text{Eq. 1.6}$$

The net heating value (NHV) calculation in the combustion zone combines the NHVs of the natural gas (fuel gas), vent gas, and steam. The NHV of steam is considered to be zero; therefore, it has no combustion contribution. The volumetric flow of the natural gas, vent gas and steam are measured by on-line flow meters. Equation 1.5 utilizes volumetric flow rate and net heating values for each stream to calculate the NHV_{cz}. The calculated NHV_{cz} for MO-3 is 341.94 BTU/SCF and MO-4 is 312.79 BTU/SCF. The NHV_{cz} for MO-3 is already above the calculated combustion zone limit ($NHV_{cz} \ge NHV_{cz\text{-}limit}$), so does not need any modification. The NHV_{cz} value and $NHV_{cz\text{-}limit}$ value for MO-4 differ by approximately 30 BTU/SCF. The MO-4 flare will require modifications in order to satisfy EPA regulations.

Hydraulic calculations show that the current natural gas system serving the flare does not have the capability of flowing 550M SCFH. To increase the available pressure drop across the flow control valve, the current natural gas pipeline must be modified. By enlarging a section of 6" pipe to 8" pipe will provide sufficient available pressure drop across the flow control valve to exceed the volumetric flow of 550M SCFH. See Appendix B for hydraulic calculations.

The Code of Federal Regulation part 60[1] also states that steam-assisted and non-steam assisted flares shall be designed and operated with an exit velocity less than 60 ft/s.

The calculated exit velocity (with steam) for MO-3 is 46.9 ft/sec and MO-4 is 51.6 ft/sec. See Appendix A for calculations and Appendix C for references.

By implementing Celanese standard practice, the height of the current flare was analyzed utilizing 500 BTU/SCF as the permissible design level (K). The MO-4 and MO-3 flares are in locations where there is constant traffic present. This K value provides calculations resembling accepted radiation at any location where personnel with appropriate clothing are present continuously. Therefore, utilizing this radiation limit in the analysis provides safe radiation at ground level.[4]

$$D = \sqrt{\frac{\tau F Q}{4\pi K}} \qquad \text{Eq. 1.7}$$

Equation 1.7 was used to determine the minimum distance from a flare to an object/person (ground level). Based on API 521, τ, the fraction of heat intensity transmitted, was considered to be 1. The Gas Processors Suppliers Association[2] and Callidus Technologies suggested a value of 0.12 for F[3], fraction of heat radiated, which is based on the emissivity values for flared gases. The Q value, heat release in BTU/SCF, used in this calculation simulates a worst case scenario for today's operations. Based on this equation, the required height of the flare is concluded to be 139.9ft for safe exposure to radiation at any location where personnel with appropriate clothing may be continuously exposed. The height of the MO-4 flare stack today is 140ft, which satisfies the required flare height for safe radiation at ground level according to Celanese's process safety standards. See Appendix C for API 521 references.

Back pressure caused by higher natural gas rates was also analyzed. The MO-4 unit can potentially trip on high AMR because of high back pressure, which potentially could result from additional natural gas in the seal pot. The back pressure analysis (hydraulic calculations), using PIC 631 and PIC 647, as illustrated in Figure 1, suggested that the increase in back pressure is approximately 1"wc (water column), which does not affect the unit during normal operation.

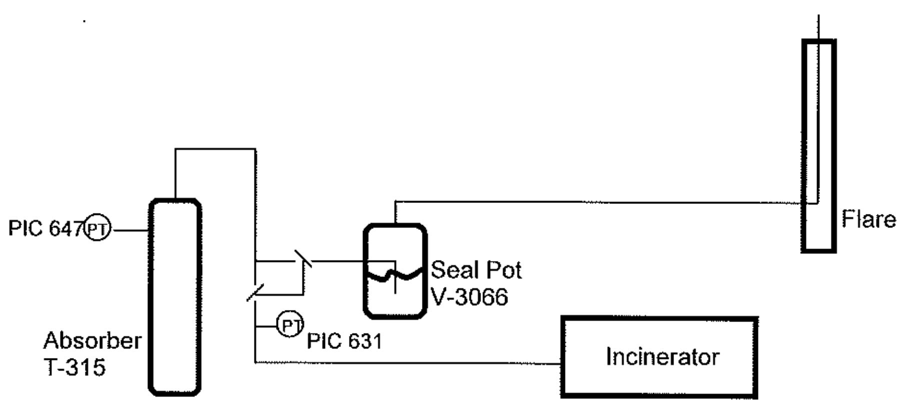

Figure 1

The material of construction or the integrity of the flare at higher natural gas rates was also a concern. The manufacturer of the MO-4 flare was contacted, Callidus

Technologies, and assured that the MO-4 flare has the capacity to operate at higher natural gas rates.

Conclusion

Calculations for MO-4 BTU value illustrated a deficiency of approximately 30 BTU/SCF, which can be met by increasing the natural gas rates to the flare by approximately 166M SCFH. This project will replace nearly 300ft of 6" pipe with 8" pipe and install a 6" control valve in place of a 4" control valve at a cost of $250M +/- 50%.

Appendix A

Calculations: BTU, Tip velocity, Flare height, Radiation

Appendix A BTU Calcs.xls

Appendix A MO-4 NG CV.xls

Appendix B

Hydraulic calculations

Appendix B Hydraulics Calcs.xls

Appendix C

References

Appendix F - References.pdf

GUR flare –TPI has been in contact with Allen Brookey and Jim Franklin of John Zink Co., to determine the appropriate steam to vent gas ratio for that flare. After providing the flare information that was requested, Mr. Brookey replied "this information is a bit of a "holy grail" in terms of flare engineering. For turn down cases such as these, we cannot yet accurately predict what the destruction efficiency is." TPI has determined that all center steam to the flare will be eliminated in order to prevent the vent to gas ratio exceeding 2 as was established in our December 20, 2011 meeting.

Should you have any questions or need additional information, please contact me at (361) 584-6104.

Sincerely,

Buddy Joyner
Sr. Environmental Specialist II

Appendix A

Calculations: BTU, Tip velocity, Flare height, Radiation

MO4 vent sample data taken on 05/18/2012			(High hydrogen BTU value)									
	Mole%	Lower Heating Valu	Vent Gas F	Vent Gas F	LFL (% Vo	Vent Gas E	Natural Ga	Steam Flo	Steam Flo	Natural Ga	Natural Ga	Net Flare BTU Value
Hydrogen	19	1212	402.401	408.5941	0.04	236.9247	937	12	256.8667	384.15	390.0622	312.7855
Argon-O2	0.697	0	14.76176	14.98895	Not flammable							
Nitrogen	71.637	0	1517.2	1540.55	Infinity							
Carbon Monoxide	0.973	320.9	20.60717	20.92432	0.125							
Carbon Dioxide	7.334	0	155.3268	157.7173	Not flammable							
Methane	0.001	907.74	0.021179	0.021505	0.044							
Methyl Formate	0.3	1023.29	6.3537	6.451485	0.045							
Methylal	0	2041.45	0	0	0.016							
Methanol	0.058	764.45	1.228382	1.247287	0.06							
Benzene	0	3579.07	0	0	0.013							
Methoxymethylal	0	2669.58	0	0	0.014							
	100	Total Veng Gas Rate		2150.495								
Vent Gas BTU Valu	BTU/hr	MBTU/hr										
Hydrogen	4.95E+08	495216.0112										
Argon-O2	0	0										
Nitrogen	0	0										
Carbon Monoxide	6714613	6714.613424										
Carbon Dioxide	0	0										
Methane	19520.9	19.52090421										
Methyl Formate	6601740	6601.740387										
Methylal	0	0										
Methanol	953488.7	953.4886672										
Benzene	0	0										
Methoxymethylal	0	0										
		509505.3746										
BTU/SCF		236.9246854										
Using Celanese NG LHV												
LFLVG	0.203899	vol %										
NHVVG	236.9247	BTU/SCF										
NHVVG-LFL	48.30859	BTU/SCF										
NHVCZ-limit	342.991	BTU/SCF										
NHVCZ	312.7855	BTU/SCF										
		difference in CZ-limit and actual CZ is			30.2055							
Adjusted NHVCZ	346.5438	BTU/SCF	w/ 550000 SCFH of natural gas									
Tip velocity	51.65199	ft/sec										
Flare height	139.9046	ft	at 500 BTU/ft^2 permissible design level									

Chemcial Engineering Article June 28, 1971, Figure 7 for 1.4 SG Solids

	Fr No	-----------	0.5	1		
	Cv	-----------	1	10		
			B =	A =		
			0.30103	-0.69315		
				2	3	
				Sch 10S	Sch 40S	
Nominal			Pipe ID	2.157	3.068	inches
Sch						

Nominal D	STD	XS	XXS	Sch 20	Sch 40	Sch 80	Sch 160	Sch 5S	Sch 10S	Sch 40S	Sch 80S
	2	3	4	5	6	7	8	9	10	11	12
0.5	0.622	0.546	0.252		0.622	0.546	0.466	0.71	0.674	0.622	0.546
0.75	0.824	0.742	0.434		0.824	0.742	0.612	0.92	0.884	0.824	0.742
1	1.049	0.957	0.599		1.049	0.957	0.815	1.185	1.097	1.049	0.957
1.25	1.38	1.278	0.896		1.38	1.278	1.16	1.53	1.442	1.38	1.278
1.5	1.61	1.5	1.1		1.61	1.5	1.338	1.77	1.682	1.61	1.5
2	2.067	1.939	1.503		2.067	1.939	1.687	2.245	2.157	2.067	1.939
2.5	2.469	2.323	1.771		2.469	2.323	2.125	2.709	2.635	2.469	2.323
3	3.068	2.9	2.3		3.068	2.9	2.624	3.334	3.26	3.068	2.9
3.5	3.548	3.364			3.548	3.364		3.834	3.76	3.548	3.364
4	4.026	3.826	3.152		4.026	3.826	3.438	4.334	4.26	4.026	3.826
5	5.047	4.813	4.063		5.047	4.813	4.313	5.345	5.295	5.047	4.813
6	6.065	5.761	4.897		6.065	5.761	5.187	6.407	6.357	6.065	5.761
8	7.981	7.625	6.875	8.125	7.981	7.625	6.813	8.407	8.329	7.981	7.625
10	10.02	9.75	8.75	10.25	10.02	9.75	8.5	10.482	10.42	10.02	9.75
12	12	11.75	10.75	12.25	11.938	11.374	10.126	12.438	12.39	12	11.75
14	13.25	13		13.376	13.124	12.5	11.188	13.688	13.624		
16	15.25	15		15.376	15	14.312	12.812	15.67	15.624		
18	17.25	17		17.376	16.876	16.124	14.438	17.67	17.624		
20	19.25	19		19.25	18.812	17.938	16.062	19.624	19.564		
22	21.25	21		21.25		19.75	17.75	21.624	21.564		
24	23.25	23		23.25	22.624	21.562	19.312	23.564	23.5		
26	25.25	25		25							
28	27.25	27		27							
30	29.25	29		29				29.5	29.376		
32	31.25	31		31	30.624						
34	33.25	33		33	32.624						
36	35.25	35		35	34.5						

Transmitter Specification Sheet

Process Data

Transmitter Number	FT-X2	Flowsheet	01-FS-952
Description	**TX-1 Reflux Flow Transmitter**		

Stream Properties

wt%						
		Temperature	90	°F	32.22222	°C
91	Methane	MW (liquid)	16.85102	0	0	0
5.19	Ethane	Tc	-107.407	°F	-77.4482	°C
1.3	Propane	Pc	653.3645	psia	45.04773	bar
0.7	Butane	Vc	100.949	ml/mole	0	0
0.406	Pentane	Density	#NUM!	Lb/ft^3	#NUM!	g/cc
0.812	Carbon Dioxide	Specific Gravity	#NUM!	0	0	0
0.49	Nitrogen	Ideal Vapor Pressure	540200.6	mmHg AB	720211.1	mbar
0	0	Ideal Vapor Pressure	10431.08	psig	720.2111	bar ABS
0	0	Heat of Vaporization	#NUM!	BTU/lb	#NUM!	cal/g
0	0	Heat Capacity	-4.15267	BTU/lb-°F	-4.15267	cal/g-°C
		Viscosity	3.07E-06	cP	3.07E-09	Pa-sec
		Conductivity	0.00199	BTU/ft-hr-°	8.22E-06	cal/cm-sec-°C
		Surface tension	#NUM!	dynes/cm	#NUM!	N/m

Transmitter Data

	Flow Rate		Flow Rate		Pressure		Upstream Pressure	
Minimum	#NUM!	gpm	107.9383	Mpph		psig	#NUM!	psig
Normal	#NUM!	gpm	107.0112	Mpph		psig	#NUM!	psig
Maximum	#NUM!	gpm	106.4704	Mpph		psig	#NUM!	psig

Mechanical Construction

Pressure Rating	150	psig	400	degF
Material of Construction	316		Wetted Parts (if different)	
Failure Mode	High			
Pipe Line Size	3"		Schedule	10
Weatherproofing (freeze Protect/Trace/Purg	Magnetic Flow Meter		Purge Fluid	

Transmitter Range

Units	gpm	Trans Range High	250	Trans Range Low	0
		Alarm High		Alarm Low	120
		Alarm Dev High	+10%	Alarm Dev Low	-10%
		Shutdown High		Shutdown Low	

Comments	Pressure Drop included in FV-X1 specification	Date:	40155
		Engr:	RAD

Transmitter Specification Sheet

Process Data

Transmitter Number	FT-761	Flowsheet	177-FS-066		
Description	**Fuel Gas to MOIV Flare Stack**				

Stream Properties

wt%		Property					
		Temperature	90	°F	32.22222	°C	
91	Methane	MW (liquid)	16.85102	0	0	0	
5.19	Ethane	Tc	-107.407	°F	-77.4482	°C	
1.3	Propane	Pc	653.3645	psia	45.04773	bar	
0.7	Butane	Vc	100.949	ml/mole	0	0	
0.406	Pentane	Density	0.042075	Lb/ft^3	#NUM!	g/cc	
0.812	Carbon Dioxide	Specific Gravity	0.581752	0	0	0	
0.49	Nitrogen	Ideal Vapor Pressure	540200.6	mmHg AB:	720211.1	mbar	
0	0	Ideal Vapor Pressure	10431.08	psig	720.2111	bar ABS	
0	0	Heat of Vaporization	#NUM!	BTU/lb	#NUM!	cal/g	
0	0	Heat Capacity	-4.15267	BTU/lb-°F	-4.15267	cal/g-°C	
		Viscosity	3.07E-06	cP	3.07E-09	Pa-sec	
		Conductivity	0.00199	BTU/ft-hr-°	8.22E-06	cal/cm-sec-°C	
		Surface tension	#NUM!	dynes/cm	#NUM!	N/m	

Transmitter Data

	Flow Rate		Flow Rate		Pressure Drop		Upstream Pressure	
Minimum	350	MSCFH	15.5	Mpph	36.12	psi	39.1	psig
Normal	555	MSCFH	25	Mpph	17.9	psi	25.9	psig
Maximum	630	MSCFH	28	Mpph	5.38	psi	17.38	psig

Mechanical Construction

Pressure Rating	150	psig	400	degF
Material of Construction	316		Wetted Parts (if different)	
Failure Mode	High			
Pipe Line Size	6"		Schedule	40
Weatherproofing (freeze Protect/Trace/Purg	Vortex Flowmeter		Purge Fluid	

Transmitter Range

Units	scfh	Trans Range High	700	Trans Range Low	0
		Alarm High		Alarm Low	
		Alarm Dev High	+10%	Alarm Dev Low	-10%
		Shutdown High		Shutdown Low	

Comments	See FCV-761 for pressure drop	Date:	41100
		Engr:	SMP

Control Valve Specification Sheet

Process Data

Valve Number			FT-X2		Flowsheet		01-FS-952		
Description			**TX-1 Reflux Control Valve**						
Stream Properties									
	wt%			Temperature	90	°F	32.22222	°C	
	91	Methane		MW (liquid)	16.85102	0	0	0	
	5.19	Ethane		Tc	-107.407	°F	-77.4482	°C	
	1.3	Propane		Pc	653.3645	psia	45.04773	bar	
	0.7	Butane		Vc	100.949	ml/mole	0	0	
	0.406	Pentane		Density	#NUM!	Lb/ft^3	#NUM!	g/cc	
	0.812	Carbon Dioxide		Specific Gravity	#NUM!	0	0	0	
	0.49	Nitrogen		Ideal Vapor Pressure	540200.6	mmHg AB	720211.1	mbar	
	0	0		Ideal Vapor Pressure	10431.08	psig	720.2111	bar ABS	
	0	0		Heat of Vaporization	#NUM!	BTU/lb	#NUM!	cal/g	
	0	0		Heat Capacity	-4.15267	BTU/lb-°F	-4.15267	cal/g-°C	
				Viscosity	3.07E-06	cP	3.07E-09	Pa-sec	
				Conductivity	0.00199	BTU/ft-hr-°	8.22E-06	cal/cm-sec-°C	
				Surface tension	#NUM!	dynes/cm	#NUM!	N/m	

Control Valve Data

		Flow Rate		Flow Rate		Pressure Drop		Upstream Pressure	
Minimum		#NUM!	gpm	107.9383	Mpph	#NUM!	psi	#NUM!	psig
Normal		#NUM!	gpm	107.0112	Mpph	#NUM!	psi	#NUM!	psig
Maximum		#NUM!	gpm	106.4704	Mpph	#NUM!	psi	#NUM!	psig
Shut Off D	100.8698	psi							

Mechanical Construction

	Pressure Rating		150	psig	400	degF	
	Material of Construction		316	Wetted Parts (if different)			
	Failure Mode		open				
	Pipe Line Size		3"	Schedule	10		

Comments	Pressure drop includes DP across FT-X2	Date:	40155
		Engr:	RAD

Control Valve Specification Sheet

Process Data

Valve Number	FCV-761	Flowsheet	117-FS-066
Description	**Fuel Gas to MOIV Flare Stack**		

Stream Properties

wt%						
		Temperature	90	°F	32.22222	°C
91.1	Methane	MW (liquid)	16.85102	0	0	0
5.19	Ethane	Tc	-107.407	°F	-77.4482	°C
1.3	Propane	Pc	653.3645	psia	45.04773	bar
0.7	Butane	Vc	100.949	ml/mole	0	0
0.406	Pentane	Density	0.042075	Lb/ft^3	#NUM!	g/cc
0.812	Carbon Dioxide	Specific Gravity	0.581752	0	0	0
0.49	Nitrogen	Ideal Vapor Pressure	540200.6	mmHg AB	720211.1	mbar
	0	Ideal Vapor Pressure	10431.08	psig	720.2111	bar ABS
0	0	Heat of Vaporization	#NUM!	BTU/lb	#NUM!	cal/g
0	0	Heat Capacity	-4.15267	BTU/lb-°F	-4.15267	cal/g-°C
		Viscosity	3.07E-06	cP	3.07E-09	Pa-sec
		Conductivity	0.00199	BTU/ft-hr-°	8.22E-06	cal/cm-sec-°C
		Surface tension	#NUM!	dynes/cm	#NUM!	N/m

Control Valve Data

	Flow Rate		Flow Rate		Pressure Drop		Upstream Pressure	
Minimum	350	MSCFH	15.5	Mpph	36.12	psi	39.1	psig
Normal	555	MSCFH	25	Mpph	17.9	psi	25.9	psig
Maximum	630	MSCFH	28	Mpph	5.38	psi	17.38	psig

Shut Off D	55	psi

Mechanical Construction

Pressure Rating	150	psig	400	degF
Material of Construction	CS	Wetted Parts (if differe	CS	
Failure Mode	Close			
Pipe Line Size	6"	Schedule	40	

Comments	Pressure drop includes pressure drop across FT-761	Date:	41100
		Engr:	SMP

Appendix B
Hydraulic calculations

Pressure Drop Calculations	Units	1	2	3	4	5	6	7	8	9
Flow Conditions		Gas	Gas	Gas	Gas	Gas	Gas	Gas	Gas	Gas
Flowrate	lb/hr	32420.21	32420.21	31287.21	25210.21	25210.21	25210.21	25210.21	24650.21	24647.28
	scfh	730028.5	730028.5	704515.9	567675.9	567675.9	567675.9	567675.9	555066	555000
	scfm	12167.14	12167.14	11741.93	9461.265	9461.265	9461.265	9461.265	9251.1	9250
	gpm									
Velocity Upstream	ft/sec	242.8535	67.01175	64.72668	52.21853	74.18342	117.4006	129.8642	136.1056	260.0936
Velocity Downstream	ft/sec	259.6286	67.07062	64.80597	52.26117	74.48171	129.8642	139.1976	150.2202	293.9091
Critical Carrying Velocity (Chem Engr)	ft/sec									
Critical Carrying Velocity (Cameron)	ft/sec									
Supply Pressure	psig	50	45.81988	45.76677	45.69279	45.64352	45.40186	39.63405	35.99113	31.2286
Discharge Pressure	psig	45.81988	45.76677	45.69279	45.64352	45.40186	39.63405	35.99113	31.2286	25.94478
Pressure Drop	psi	4.180123	0.053112	0.073976	0.049273	0.241658	5.767812	3.642916	4.762534	5.283814
Fluid Properties										
Molecular Weight	none	16.85017	16.85017	16.85017	16.85017	16.85017	16.85017	16.85017	16.85017	16.85017
Temperature	°F	90	90	90	90	90	90	90	90	90
Viscosity	cP	0.011347	0.011347	0.011347	0.011347	0.011347	0.011347	0.011347	0.011347	0.011347
Density Upstream	lb/ft3	0.184833	0.172891	0.172739	0.172528	0.172387	0.171697	0.155218	0.144811	0.131204
Density Downstream	lb/ft3	0.172891	0.172739	0.172528	0.172387	0.171697	0.155218	0.144811	0.131204	0.116109
Friction Factor Calculation										
Epsilon	none	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015
Relative Roughness	in/in	0.000297	0.000151	0.000151	0.000151	0.00018	0.000226	0.000226	0.000226	0.000297
Straight Pipe friction factor	none	0.015166	0.013774	0.013799	0.01397	0.014196	0.0146	0.0146	0.014611	0.015245
Turbulent friction factor	none	0.014903	0.012973	0.012973	0.012973	0.013434	0.014072	0.014072	0.014072	0.014903
Piping										
Nominal Diameter	inches	6	12	12	12	10	8	8	8	6
Pipe Schedule		Sch 40	Sch 40	Sch 40	Sch 40	Sch 40	Sch 40	Sch 40	Sch 40	Sch 40
Pipe Inside Diam	inches	6.065	11.938	11.938	11.938	10.02	7.981	7.981	7.981	6.065
Pipe Length	feet	7.9	27	49.5	15	61.5	459	339	270	26
'K' Value for Piping	none	0.237048	0.373824	0.68661	0.210632	1.045578	10.07625	7.44194	5.931717	0.784223
Fittings										
90o Elbows	number	1	0	0	0	0	20	7	19	2
45o Elbows	number	0	0	0	0	0	3	1	2	0
Globe Valves	number	0	0	0	0	0	0	0	0	0
Gate Valves	number	0	0	0	0	0	0	1	2	1
Plug Valves	number	1	0	0	0	0	2	1	0	0
Butterfly Valves	number	0	0	0	0	0	0	0	0	0
Check Valves	number	0	0	0	0	0	0	0	0	1
Runs Through Tees	number	0	1	1	1	3	2	0	1	0
Branches Through Tees	number	1	0	0	0	0	0	1	0	0
'K' Value for Fittings		2.086407	0.259459	0.259459	0.259459	0.806068	11.08853	4.840677	8.977766	2.503688
Entrance and Exit Losses										
Contractions	none	0	0	0	1	1	0	0	1	0
Expansions	number	1	0	0	0	0	0	0	0	0
K' Value Contracts & Expands	none	1	0	0	0.5	0.5	0	0	0.5	0
Orifice Calculations										
Orifice Diameter	inches	0	0	0	0	0	0	0	0	0
Orifice Plate Thickness	inches	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Orifice Beta Factor	none	0	0	0	0	0	0	0	0	0
Orifice Coefficient	none	0.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
'K' Value for Orifice	none	0	0	0	0	0	0	0	0	0
Valve Calculations										
Valve Cv Value	none	10	10	10	10	10	10	10	10	10
Number of Valves	none	0	0	0	0	0	0	0	0	0
'K' Value for Valves	none	0	0	0	0	0	0	0	0	0
Valve Cv Value	none	10	10	10	10	10	10	10	10	10
Number of Valves	none	0	0	0	0	0	0	0	0	0
'K' Value for Valves	none	0	0	0	0	0	0	0	0	0
Other Equipment										
Enter Other 'K' Values	none	0	0	0	0	0	0	0	0	0
Total Overall 'K' Value	none	3.323455	0.633282	0.946069	0.970091	2.351646	21.16478	12.28262	15.40948	3.287912
Flowrate Calculation										
Friction Data at given Conditions										
	Velocity He	1.175494	0.083719	0.078038	0.050729	0.102299	0.255184	0.282275	0.28927	0.957103
	e/D	0.000297	0.000151	0.000151	0.000151	0.00018	0.000226	0.000226	0.000226	0.000297
	Re No.	2972697	1510254	1457474	1174385	1399183	1756648	1756648	1717628	2259976
	A	8.148872	8.625	8.619882	8.585384	8.486302	8.33771	8.33771	8.335724	8.135845
	B	8.120037	8.517924	8.509915	8.456817	8.390697	8.274915	8.274915	8.271729	8.098803
	C	8.12028	8.520734	8.512879	8.460865	8.393036	8.275985	8.275985	8.27284	8.099203
	(B-A)^2	0.000831	0.011465	0.012093	0.01653	0.00914	0.003943	0.003943	0.004095	0.001372
	C-2B+A	0.029078	0.109886	0.112932	0.132615	0.097944	0.063866	0.063866	0.065106	0.037443
	f	0.015166	0.013774	0.013799	0.01397	0.014196	0.0146	0.0146	0.014611	0.015245
Full Turbulent Flow Values										
Full Turbulent Flow Values										
	A	8.19152	8.779722	8.779722	8.779722	8.627594	8.429973	8.429973	8.429973	8.19152
	B	8.19152	8.779722	8.779722	8.779722	8.627594	8.429973	8.429973	8.429973	8.19152
	C	8.19152	8.779722	8.779722	8.779722	8.627594	8.429973	8.429973	8.429973	8.19152
	(B-A)^2	8.59E-19	4.58E-18	4.58E-18	4.58E-18	2.98E-18	1.7E-18	1.7E-18	1.7E-18	8.59E-19
	C-2B+A	9.27E-10	2.14E-09	2.14E-09	2.14E-09	1.73E-09	1.31E-09	1.31E-09	1.31E-09	9.27E-10
	f	0.014903	0.012973	0.012973	0.012973	0.013434	0.014072	0.014072	0.014072	0.014903
Compressinle Flow Limits										
k (ratio of specific heats Cp/Cv)	none	1.29136	1.29136	1.29136	1.29136	1.29136	1.29136	1.29136	1.29136	1.29136
DP/P' Maximum	none	0.651944	0.391539	0.463912	0.46947	0.608559	0.832998	0.787571	0.808036	0.650662
DP/P' Actual	none	0.064612	0.000878	0.001223	0.000816	0.004005	0.095974	0.067052	0.093959	0.115054
'Y' Minimum	none	0.663579	0.567995	0.593427	0.59538	0.644393	0.718691	0.712036	0.719326	0.663146
'Y' Actual	none	0.966659	0.999032	0.998928	0.999297	0.99766	0.967589	0.975484	0.967363	0.940435
PRD Calculations										
PRD Set pressure	psig	100								
Percent Pressure drop	inlet/outlet	0.041801	0.000531	0.00074	0.000493	0.002417	0.057678	0.036429	0.047625	0.052838

Appendix C
References

§ 60.18 General control device requirements.

(a) *Introduction.* This section contains requirements for control devices used to comply with applicable subparts of parts 60 and 61. The requirements are placed here for administrative convenience and only apply to facilities covered by subparts referring to this section.

(b) *Flares.* Paragraphs (c) through (f) apply to flares.

(c)(1) Flares shall be designed for and operated with no visible emissions as determined by the methods specified in paragraph (f), except for periods not to exceed a total of 5 minutes during any 2 consecutive hours.

(2) Flares shall be operated with a flame present at all times, as determined by the methods specified in paragraph (f).

(3) Flares shall be used only with the net heating value of the gas being combusted being 11.2 MJ/scm (300 Btu/scf) or greater if the flare is steam-assisted or air-assisted; or with the net heating value of the gas being combusted being 7.45 MJ/scm (200 Btu/scf) or greater if the flare is nonassisted. The net heating value of the gas being combusted shall be determined by the methods specified in paragraph (f).

(4)(i) Steam-assisted and nonassisted flares shall be designed for and operated with an exit velocity, as determined by the methods specified in paragraph (f)(4), less than 18.3 m/sec (60 ft/sec), except as provided in paragraphs (b)(4) (ii) and (iii).

(ii) Steam-assisted and nonassisted flares designed for and operated with an exit velocity, as determined by the methods specified in paragraph (f)(4), equal to or greater than 18.3 m/sec (60 ft/sec) but less than 122 m/sec (400 ft/sec) are allowed if the net heating value of the gas being combusted is greater than 37.3 MJ/scm (1,000 Btu/scf).

(iii) Steam-assisted and nonassisted flares designed for and operated with an exit velocity, as determined by the methods specified in paragraph (f)(4), less than the velocity, V_{max}, as determined by the method specified in paragraph (f)(5), and less than 122 m/sec (400 ft/sec) are allowed.

(5) Air-assisted flares shall be designed and operated with an exit velocity less than the velocity, V_{max}, as determined by the method specified in paragraph (f)(6).

(6) Flares used to comply with this section shall be steam-assisted, air-assisted, or nonassisted.

(d) Owners or operators of flares used to comply with the provisions of this subpart shall monitor these control devices to ensure that they are operated and maintained in conformance with their designs. Applicable subparts will provide provisions stating how owners or operators of flares shall monitor these control devices.

(e) Flares used to comply with provisions of this subpart shall be operated at all times when emissions may be vented to them.

(f)(1) Reference Method 22 shall be used to determine the compliance of flares with the visible emission provisions of this subpart. The observation period is 2 hours and shall be used according to Method 22.

(2) The presence of a flare pilot flame shall be monitored using a thermocouple or any other equivalent device to detect the presence of a flame.

(3) The net heating value of the gas being combusted in a flare shall be calculated using the following equation:

$$H_T = K \sum_{i=1}^{n} C_i H_i$$

where:

H_T=Net heating value of the sample, MJ/scm; where the net enthalpy per mole of offgas is based on combustion at 25 °C and 760 mm Hg, but the standard temperature for determining the volume corresponding to one mole is 20 °C;

$$K = \text{Constant, } 1.740 \times 10^{-7} \left(\frac{1}{\text{ppm}}\right) \left(\frac{\text{g mole}}{\text{scm}}\right) \left(\frac{\text{MJ}}{\text{kcal}}\right)$$

where the standard temperature for $\left(\frac{\text{g mole}}{\text{scm}}\right)$ is 20°C;

C_i=Concentration of sample component i in ppm on a wet basis, as measured for organics by Reference Method 18 and measured for hydrogen and carbon monoxide by ASTM D1946–77 (Incorporated by reference as specified in § 60.17); and

H_i=Net heat of combustion of sample component i, kcal/g mole at 25 °C and 760 mm Hg. The heats of combustion may be determined using ASTM D2382–76 (incorporated by reference as specified in § 60.17) if published values are not available or cannot be calculated.

(4) The actual exit velocity of a flare shall be determined by dividing the volumetric flowrate (in units of standard temperature and pressure), as determined by Reference Methods 2, 2A, 2C, or 2D as appropriate; by the unobstructed (free) cross sectional area of the flare tip.

(5) The maximum permitted velocity, V_{max}, for flares complying with paragraph (c)(4)(iii) shall be determined by the following equation.

$$\text{Log}_{10} (V_{max})=(H_T+28.8)/31.7$$

V_{max}=Maximum permitted velocity, M/sec
28.8=Constant
31.7=Constant
H_T=The net heating value as determined in paragraph (f)(3).

(6) The maximum permitted velocity, V_{max}, for air-assisted flares shall be determined by the following equation.

$$V_{max}=8.706+0.7084 (H_T)$$

V_{max}=Maximum permitted velocity, m/sec
8.706=Constant
0.7084=Constant
H_T=The net heating value as determined in paragraph (f)(3).

[51 FR 2701, Jan. 21, 1986]

§ 60.19 General notification and reporting requirements.

(a) For the purposes of this part, time periods specified in days shall be measured in calendar days, even if the word "calendar" is absent, unless otherwise specified in an applicable requirement.

(b) For the purposes of this part, if an explicit postmark deadline is not specified in an applicable requirement for the submittal of a notification, application, report, or other written communication to the Administrator, the owner or operator shall postmark the submittal on or before the number of days specified in the applicable requirement. For example, if a notification must be submitted 15 days before a particular event is scheduled to take place, the notification shall be postmarked on or before 15 days preceding the event; likewise, if a notification must be submitted 15 days after a particular event takes place, the notification shall be delivered or postmarked on or before 15 days following the end of the event. The use of reliable non-Government mail carriers that provide indications of verifiable delivery of information required to be submitted to the Administrator, similar to the postmark provided by the U.S. Postal Service, or alternative means of delivery agreed to by the permitting authority is acceptable.

(c) Notwithstanding time periods or postmark deadlines specified in this part for the submittal of information to the Administrator by an owner or operator, or the review of such information by the Administrator, such time periods or deadlines may be changed by mutual agreement between the owner or operator and the Administrator. Procedures governing the implementation of this provision are specified in paragraph (f) of this section.

(d) If an owner or operator of an affected facility in a State with delegated authority is required to submit periodic reports under this part to the State, and if the State has an established timeline for the submission